

MID-COLUMBIA RIVER FEASIBILITY STUDY:
PHYSICAL AND CHEMICAL ANALYSES
OF HANFORD REACH SEDIMENTS

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BACKGROUND

The National Marine Fisheries Service has long been involved in research on the fisheries and habitat priority issues of: (1) dams and hydroelectric power generation; (2) point and non-point source industrial waste discharge; and (3) waterway development (including dredging, filling, and dredge disposal). Because sedimentation and siltation are occurring to some extent in the forebays and reservoirs of Columbia River dams, it may eventually be necessary to dredge in some of these areas. Information on the nature, origin, and extent of industrially-discharged materials which may have accumulated at sites subject to future excavation will contribute to salmonid and habitat management in the Columbia River Basin by state and federal fishery and environmental agencies, Indian tribes, and power entities.

The entire United States mainstem Columbia River is impounded behind a succession of dams except for a 52-mile section which extends from Richland, Washington, at River Mile (RM) 345 upriver to Priest Rapids Dam (RM 397). Commonly termed the Hanford Reach, this section remains the only free-flowing segment of the Columbia River above Bonneville Dam (RM 145); it provides a large mainstem spawning area for a valuable population of fall chinook salmon. It has been proposed by the COE that a shallow-draft navigation channel be established through the Hanford Reach to accommodate river barge transportation upstream to the Wenatchee, Washington, area (RM 470). As the excavation of the channel may result in the resuspension and release of any contaminants associated with the sediments, a determination of potentially hazardous materials in the sediments is of primary concern.

The specific objectives of the present study were to: (1) provide appropriate physical and chemical analyses of representative samples of sediment likely to be dredged from the Hanford Reach and (2) provide an evaluation of the potential for the introduction of contaminants into the water column.

METHODS

The four sites sampled in August 1986 are relatively shallow and would require excavation for the proposed Hanford Reach navigation channel (Fig. 1). Location 1, well upriver from Hanford, was selected as a reference station presumably not influenced by activities at Hanford. Locations 2 and 3 are adjacent to the center of the Hanford riverside operations, and Location 4 is downriver from most of the Hanford complex.

Initially, the sampling plan included a transect of six sediment core samples at each of the four locations. The six samples from each location were to be combined, yielding four composite samples. However, repeated attempts at each of the locations to obtain sediment in mid-river were unsuccessful since the bottom throughout much of this free-flowing segment of the Columbia River consists primarily of rocks, cobbles, and boulders. In addition to various efforts with a gravity-corer and a Ponar grab-sampler, many attempts to obtain sediment were made at each location using a 6 1/2-in OD by 6-in long cast-iron pipe with a cleaned cloth bag clamped over one end. This sampler was dragged along the bottom for short periods of time, usually less than 15 sec. These endeavors produced quite a few walnut- to fist-sized rocks but no fine sediment. Finally, sediment was obtained by hand along the shore on each side of the river at all four locations. At each

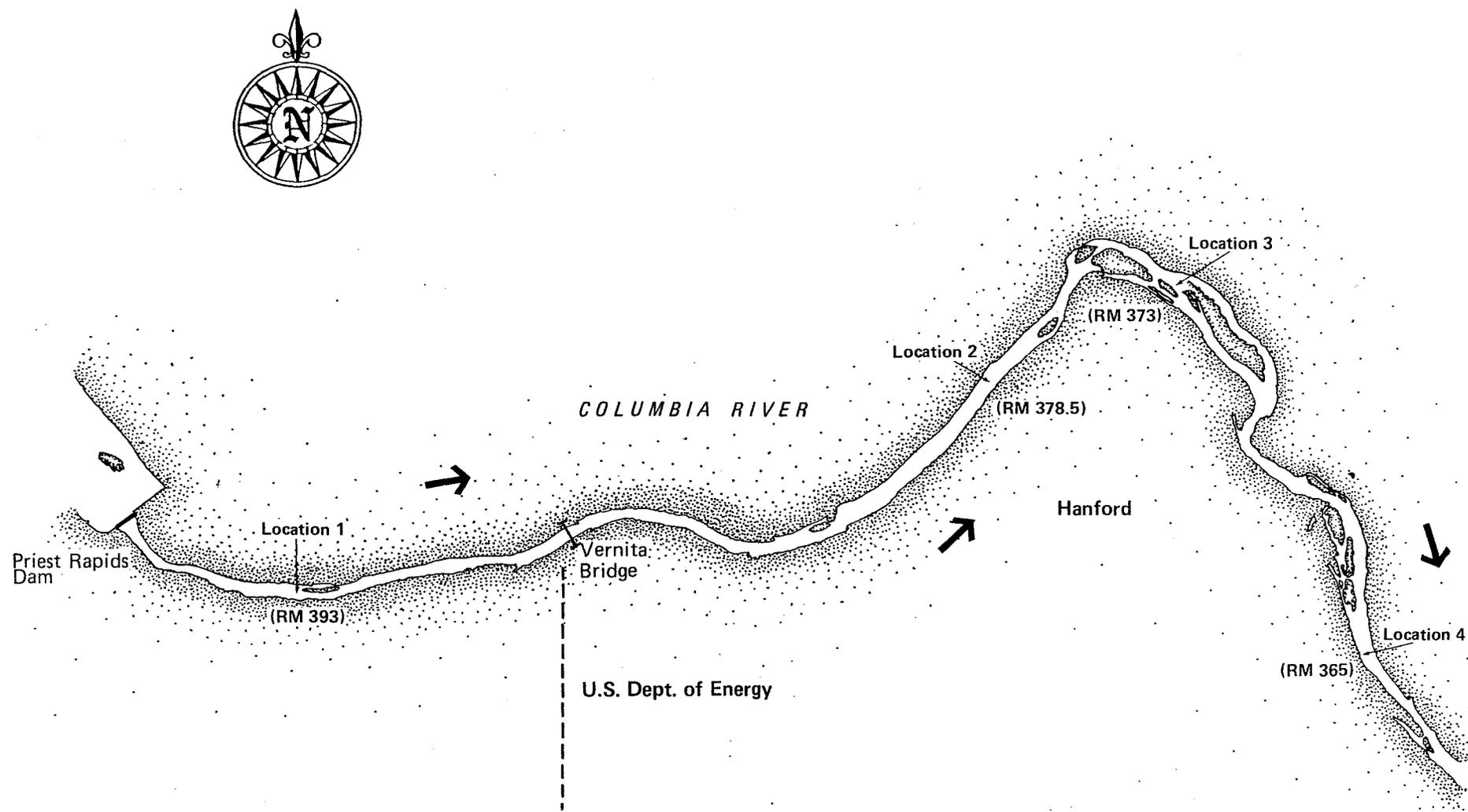


Figure 1.--Sampling locations for Hanford Reach sediment study, Columbia River.

sampling site, rocks and gravel were cleared away with a stainless-steel spoon; sediment from at or just below the fluctuating waterline was scooped into a large stainless-steel bucket, mixed thoroughly, and distributed into separate sample bottles for the various analyses. Sample bottles for organic chemical analyses were pre-rinsed with dichloromethane (CH_2Cl_2). All samples were immediately frozen with dry ice and eventually stored at -18°C . Samples from each side of the river were combined, by location, providing four composite samples for each analysis.

In October 1986, a Ponar grab-sampler was used to collect sediment at four sites in the forebay of McNary Dam. Preparation of sample bottles and treatment of samples after collection were the same as with the Hanford samples.

Analyses for sediment physical structure and total heavy metal content (using strong-acid extract technique) were conducted by Northwest Testing Laboratories, Inc., Portland, Oregon (ASTM 1984a, 1984b; USEPA 1982). All organic chemical analyses were done by the National Analytical Facility, Northwest and Alaska Fisheries Center. Analytical methods and instrumentation for organic analyses are discussed in MacLeod et al. (1985). Estimates of alpha and beta radioactivity were determined with a Ludlum Geiger counter^{01/}, Model 14C with Model 44-7 end-window GM. Gamma radioactivity was measured with a Micromedic Systems® 4/200 automatic gamma counter. Surface water, collected at each of the four sampling locations, was analyzed for turbidity (using an HF Instruments®, Model DRT-15 turbidimeter) and fluoride (using a HACH Co.® fluoride meter with ion selective electrode).

^{1/} Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

RESULTS AND DISCUSSION

Water: Turbidity/Fluoride

Turbidity measurements taken in August from surface samples at each of the four locations indicate uniformly low turbidity throughout the study area (Table 1). Fluoride concentrations, determined as a possible index to aluminum-production activity upriver, were also uniformly low (Table 1). These low fluoride concentrations, which are near "background" levels for the Columbia River, may reflect improved wastewater-discharge techniques only recently employed by upriver industry. For example, an aluminum plant built in 1952 near Wenatchee, Washington (RM 455), discharged 10 - 15 million gal of wastewater per day directly into the Columbia River until 1977 when it first began to pond and treat its wastes before discharge. In 1985, the Wenatchee aluminum plant converted air-emission control systems from wet- to dry-scrubbing and thereby eliminated a large water and fluoride discharge from those systems. Consequently, fluoride concentrations may be lower in the Columbia River below Wenatchee than they have been in over 30 years (Damkaer and Dey 1986b).

Sediments

Particle Size Distribution and %-Carbon

Results of particle size distribution and %-carbon analyses show very little inter-location difference (Table 2). It should be reiterated that in almost all cases these analyses were performed on material collected by hand after a variable layer of rocks had been removed. Only the sample collected from the eastern shore at Location 4 was taken without removing covering material. While Location 4 sediments contained a greater proportion of fine materials than the other three locations, the sediment from all four locations

Table 1.--Turbidity and fluoride concentrations of river water in the Hanford Reach, Columbia River, August 1986 (see Fig. 1 for station locations).

	Turbidity (NTU, surface) ^a	Fluoride (ppm, surface)
Location 1 (RM 393)	0.2	0.11
Location 2 (RM 378.5)	0.2	0.11
Location 3 (RM 373)	0.2	0.10
Location 4 (RM 365)	0.2	0.10

^a/
- HF Instruments, Model DRT-15 turbidimeter.

^b/
- **HACH** Co., fluoride meter with ion selective electrode.

Table 2.--Particle size distribution and % carbon for sediment collected in the Hanford Reach, Columbia River, August 1986 (see Fig. 1 for station locations).

	Location 1 (RM 393)	Location 2 (RM 378.5)	Location 3 (RM 373)	Location 4 (RM 365)
Gravel (19.1 - 1.0 mm)	37	30	31	30
Sand (1.0 - 0.074 mm)	58	66	59	50
Silt (0.074 - 0.005 mm)	3	2	7	6
Clay (<0.005 mm)	2	2	3	14
Carbon	0.33	0.20	0.14	0.27

consisted mostly of relatively coarse sand and gravel. Carbon was less than 0.5% at all locations.

Since the sediments collected for these analyses were only from bank deposits, it is likely that they consisted of finer material than would be found in the channel bed deposits that would actually be dredged.

Heavy Metals

The toxicity of metals to aquatic organisms varies considerably depending on species, temperature, water hardness, pH, and other materials present. Metals and other chemical contaminants interact in complex, often poorly understood ways with sediment particles and may be present in sediments in a variety of adsorbed or solid forms. At present, there is no known simple relationship between the concentration of a contaminant in sediment and its toxicity to aquatic organisms in contact with that sediment. However, it is generally believed that contaminated sediments can serve as reservoirs for the continual recontamination of the overlying water column and that aquatic organisms interact with contaminated sediments indirectly through consumption of food organisms that are intimately associated with the sediments (Varanasi et al. 1985). The resuspension and activation of contaminants brought on by channel dredging would very likely accelerate the effects of these mechanisms.

Concentrations of heavy metals at four locations of the Hanford Reach are shown in Table 3. The range of concentrations found at all locations was narrow indicating a uniform distribution of heavy metals in the shoreline

Table 3.--Heavy metal concentrations in sediment collected in the Hanford Reach (1986) and near John Day Dam (1982), Columbia River (see Fig. 1 for Hanford Reach station locations and Damkaer and Dey 1986 for station locations near John Day Dam).

Metal (ppm, dry weight)	Hanford Reach				John Day Dam Region
	Location 1 (RM 393)	Location 2 (RM 378.5)	Location 3 (RM 373)	Location 4 (RM 365)	Columbia River/lagoon near Al-plant (RM 217)
Aluminum (Al)	1.2	0.6	0.4	0.4	450-880
Arsenic (As)	0.006	0.006	0.006	0.002	0.2-0.3
Barium (Ba)	1.0	0.4	0.4	0.6	7.6-9.6
Cadmium (Cd)	0.8	0.2	0.6	0.2	0.1-0.2
Chromium (Cr)	<0.1	<0.1	<0.1	<0.1	1.0-1.2
Copper (Cu)	1.8	1.4	1.2	1.6	1.2-2.0
Iron (Fe)	7.4	6.0	7.6	2.2	100-200
Lead (Pb)	3.8	2.2	2.6	1.4	0.9-1.3
Manganese (Mn)	20	6.0	16	4.0	1.2
Mercury (Hg)	<0.01	<0.01	<0.01	<0.01	0.01-0.02
Selenium (Se)	0.004	0.003	0.001	0.001	0.02
Zinc (Zn)	22	6.0	18	4.0	5.7-8.3

sediments throughout the Hanford Reach. There were no significant differences between metal concentrations at Location 1, the upriver "background" station assumed to be free from the influence of activities at Hanford, and Locations 2 - 4. As there is very little information available regarding the natural or background heavy-metal concentrations in sediments of the Columbia River above the Hanford Reach, it is difficult to conclude whether the concentrations detected in this study indicate possible upriver industrial influence; simply reflect background levels due to the natural composition of parent materials; or are due to other, unidentified, sources.

Also included in Table 3 are the ranges of concentrations found for these metals in sediment collected from the Columbia River adjacent to an aluminum plant outfall and in a nearby lagoon just upriver from John Day Dam (Damkaer and Dey 1986a). Not surprisingly, for most of the metals the concentrations were higher in the polluted sediments near the aluminum plant than in the Hanford Reach sediments. However, the relatively coarse sediments of the Hanford Reach contained concentrations of cadmium (Cd), copper (Cu), lead (Pb), manganese (Mn), and zinc (Zn) equal to or greater than concentrations found in the fine sediments of the Columbia River near the aluminum plant at John Day Dam. While these metals are among the most likely to have physiological or behavioral effects on fish and other aquatic organisms, the concentrations reported here represent the total metal content of the materials analyzed. As with the source of these metals in the Hanford Reach, their bioavailability and potential for adverse effects cannot be accurately assessed without further study.

Organic Pollutants

The results of analyses for specific aromatic and chlorinated hydrocarbons are presented in Tables 4 and 5. No measurable concentrations of any of these compounds were found at the four locations in the Hanford Reach. Although likely upriver sources for organic pollutants exist and have been identified, the bulk of the contaminants from these sources most likely accumulates where considerable sedimentation is possible; these sites would include areas just upriver from the major dams. Four sediment samples were collected in October 1986 just upriver from the restricted zone in the forebay of McNary Dam (RM 292). One sample was taken near the south shore (Station 1), one near the north shore (Station 3), and two samples were taken near mid-river (Stations 2 and 4; water-depth approximately 30 m). However, concentrations of aromatic and chlorinated hydrocarbons were only slightly above detectable levels (Tables 6 and 7).

In the Hanford Reach of the Columbia River, the limitations on sampling technique imposed by the physical conditions allowed the collection of only the uppermost few centimeters of sediment. Nevertheless, because it is likely that this free-flowing segment of the river is continuously cutting its bed and reworking and transporting exposed sediments, no assumptions as to age of deposits can be made from their vertical position in the streambed strata. The chemical composition of sediment collected on the river banks may therefore be representative of channel sediments as well. In the forebay of McNary Dam, however, it is more likely that the materials collected reflect pollutant levels for only the most recent years. Their composition indicates very little regarding the possible extent of chemical contamination of older, deeper sediments which may have been formed and deposited near McNary Dam

Table 4.--Concentrations of aromatic hydrocarbons in sediment collected in the Hanford Reach, Columbia River, August 1986 (see Fig. 1 for station locations).

a,b,c

Concentrations of aromatic hydrocarbons in Hanford sediment samples, ng/g (ppb) dry weight.

location (composite) # sample #	1 61-17	2 61-18	3 61-19	4 61-20
naphthalene	< 7	< 6	< 7	< 7
2-methylnaphthalene	< 7	< 7	< 7	< 8
1-methylnaphthalene	< 7	< 7	< 7	< 8
biphenyl	< 7	< 6	< 7	< 7
2,6-dimethylnaphthalene	< 7	< 6	< 7	< 7
acenaphthene	< 7	< 7	< 7	< 8
fluorene	< 6	< 6	< 7	< 7
phenanthrene	< 6	< 6	< 6	< 7
anthracene	< 6	< 6	< 6	< 7
1-methylphenanthrene	< 6	< 6	< 6	< 7
fluoranthene	< 6	< 6	< 6	< 7
pyrene	< 6	< 6	< 6	< 7
benz[a]anthracene	< 9	< 9	< 8	< 11
chrysene	< 10	< 9	< 8	< 13
benzo[e]pyrene	< 11	< 11	< 10	< 15
benzo[a]pyrene	< 12	< 12	< 11	< 16
perylene	< 13	< 13	< 11	< 17
dibenz[a,h]anthracene	< 16	< 16	< 14	< 21
Sum of the concentrations of the above analytes				
% recovery of:				
naphthalene-d8	89	93	86	88
acenaphthene-d10	91	96	92	92
perylene-d12	77	80	90	65
sample weight, g	10.03	10.00	9.99	10.04
% dry weight	79.2	82.3	75.8	70.1

a The concentrations of analytes from naphthalene through 1-methylnaphthalene were calculated using naphthalene-d8 as the internal standard; analytes from biphenyl through pyrene were calculated using acenaphthene-d10; analytes from benz[a]anthracene through dibenz[a,h]anthracene were calculated using perylene-d12.

b The less than" symbol (<) indicates that the analyte was not detected in concentrations above the stated value.

c Concentrations and initial identifications were determined using flame ionization detection GC.

Figure S.--Concentrations of chlorinated compounds in sediment collected in the Hanford Reach, Columbia River, August 1986 (see Fig. 1 for station locations).

a,b,c

Concentrations of chlorinated analytes in Hanford sediment samples, ng/g (ppb) dry weight.

location (composite) # sample #	1 61-17	2 61-18	3 61-19	4 61-20
hexachlorobenzene	< 1	< 1	< 1	< 1
lindane (gamma-BHC)	< 1	< 1	< 1	< 1
heptachlor	< 1	< 1	< 1	< 1
aldrin	< 1	< 1	< 1	< 1
heptachlorepoide	< 1	< 1	< 1	< 1
alpha-chlordane	< 1	< 1	< 1	< 1
trans-nonachlor	< 1	< 1	< 1	< 1
dieldrin	< 1	< 1	< 1	< 1
mirex	< 1	< 1	< 1	< 1
o,p'-DDE	< 1	< 1	< 1	< 1
p,p'-DDE	< 1	< 1	< 1	< 1
o,p'-DDD	< 1	< 1	< 1	< 1
p,p'-DDD	< 1	< 1	< 1	< 1
o,p'-DDT	< 1	< 1	< 1	< 1
p,p'-DDT	< 1	< 1	< 1	< 1
dichlorobiphenyls	< 1	< 1	< 1	< 2
trichlorobiphenyls	< 1	< 1	< 1	< 1
tetrachlorobiphenyls	< 1	< 1	< 1	< 1
pentachlorobiphenyls	< 2	< 1	< 1	< 1
hexachlorobiphenyls	< 1	< 1	< 1	< 1
heptachlorobiphenyls	< 1	< 1	< 1	< 1
octachlorobiphenyls	< 1	< 1	< 1	< 1
nonachlorobiphenyls	< 1	< 1	< 1	< 1
dichlorobutadienes	< 1	< 1	< 1	< 1
trichlorobutadienes	< 1	< 1	< 1	< 1
tetrachlorobutadienes	< 1	< 1	< 1	< 1
pentachlorobutadienes	< 1	< 1	< 1	< 1
hexachlorobutadienes	< 1	< 1	< 1	< 1
Sum of the concentrations of the above analytes				
recovery of:				
4,4'-dibromooctafluorobiphenyl	130	120	120	91
sample weight, g	10.03	10.00	9.99	10.04
% dry weight	79.2	82.3	75.8	70.1

- a The concentrations of analytes were calculated using 4,4'-dibromooctafluorobiphenyl as the internal standard.
 b The "less than" symbol (<) indicates that the analyte was not detected in concentrations above the stated value.
 c Concentrations and initial identifications were determined using electron capture detection GC.

Figure 6.--Concentrations of aromatic hydrocarbons in sediment collected near McNary Dam, Columbia River, October 1986.

Concentrations of aromatic hydrocarbons in McNary Dam sediment samples, ng/g (ppb) dry weight. a,b,c

station # sample #	1 61-21	2 61-22	3 61-23	4 61-24
naphthalene	< 16	< 10	< 32	< 32
2-methylnaphthalene	< 4	< 11	< 11	< 9
1-methylnaphthalene	< 26	< 5	< 24	< 23
biphenyl	< 6	< 5	< 5	< 5
2,6-dimethylnaphthalene	< 13	< 5	< 5	< 5
acenaphthene	< 4	< 5	< 5	< 5
fluorene	< 3	22	< 5	7
phenanthrene	< 3	15	< 4	< 4
anthracene	< 3	6	< 4	< 4
1-methylphenanthrene	< 3	< 3	< 4	< 4
fluoranthene	< 4	7	< 5	11
pyrene	< 4	< 3	< 5	9
benz[a]anthracene	< 2	< 3	< 4	< 3
chrysene	< 4	< 3	< 4	< 4
benzo[e]pyrene	< 4	< 5	< 6	< 5
benzo[a]pyrene	< 2	< 3	< 4	< 3
perylene	11	7	< 4	7
dibenz[a,h]anthracene	< 4	8	< 6	18
Sum of the concentrations of the above analytes	11	65		52
recovery of:				
naphthalene-d8	63	79	57	72
acenaphthene-d10	66	81	57	74
perylene-d12	65	87	55	76
sample weight, g	10.24	10.14	10.01	9.99
% dry weight	55.2	41.1	51.4	44.1

- a The concentrations of analytes from naphthalene through 1-methylnaphthalene were calculated using naphthalene-d8 as the internal standard; analytes from biphenyl through pyrene were calculated using acenaphthene-d10; analytes from benz[a]anthracene through dibenz[a,h]anthracene were calculated using perylene-d12.
- b The "less than" symbol (<) indicates that the analyte was not detected in concentrations **above** the stated value.
- c Concentrations and initial identifications were determined using flame **ionization** detection GC.

Figure 7.--Concentrations of chlorinated compounds in sediment collected near McNary Dam, Columbia River, October 1986.

Concentrations of chlorinated analytes in McNary Dam sediment samples, ng/g (ppb) dry weight. ^{a,b,c}

station # sample #	1 61-21	2 61-22	3 61-23	4 61-24
hexachlorobenzene	1	3	2	3
lindane (gamma-BHC)	< 1	< 2	< 1	< 1
heptachlor	< 2	< 2	< 2	< 2
aldrin	< 1	< 2	< 2	< 2
heptachlorepoide	< 3	< 4	< 4	< 4
alpha-chlordane	< 1	< 1	< 1	< 1
trans-nonachlor	2	2	3	3
dieldrin	< 1	< 2	< 2	< 2
mirex	< 2	< 5	< 3	< 3
o,p'-DDE	< 2	< 2	< 3	< 3
p,p'-DDE	4	6 -d	5	5
o,p'-DDD	< 3	< 9	< 9'	< 9
p,p'-DDD	3	9 -d	10	9
o,p'-DDT	< 2	< 3	< 3	< 3
p,p'-DDT	< 1	< 2	< 2	< 2
dichlorobiphenyls	< 8	< 10	< 11	< 11
trichlorobiphenyls	< 8	< 6	< 13	< 6
tetrachlorobiphenyls	< 6	< 14	< 12	< 14
pentachlorobiphenyls	< 8	< 3	< 15	< 13
hexachlorobiphenyls	< 8	< 2	< 7	< 11
heptachlorobiphenyls	< 4	< 2	< 3	< 10
octachlorobiphenyls	< 1	< 2	< 2	< 2
nonachlorobiphenyls	< 5	< 6	< 6	< 6
dichlorobutadienes	< 8	< 10	< 11	< 11
trichlorobutadienes	< 16	< 12	< 20	< 12
tetrachlorobutadienes	< 24	< 20	< 24	< 20
pentachlorobutadienes	< 24	< 9	< 20	< 20
hexachlorobutadienes	< 10	< 4	< 10	< 15
Sum of the concentrations of the above analytes	10	20	20	20
recovery of: 4,4'-dibromooctafluorobiphenyl	83	100	58	82
sample weight, g	10.24	10.14	10.01	9.99
% dry weight	55.2	41.1	51.4	44.1

a The concentrations of analytes were calculated using 4,4'-dibromooctafluorobiphenyl as the internal standard.

b The "less than" symbol (<) indicates that the analyte was not detected in concentrations above the stated value.

c Concentrations and initial identifications were determined using electron capture detection GC.

d Identification of analyte was confirmed by GC/MS.

during the many years of relatively little or no regulation of industrial discharge.

Radioactivity

Since January 1971 when the last of nine plutonium production reactors using direct discharge of once-through cooling waters into the Columbia River was closed, the biota and sediments of the Hanford Reach have been exposed to much lower ambient levels of radionuclides (Cushing et al. 1981). In the river-reservoir complex extending below Hanford to McNary Dam, fission-produced radionuclides decreased to extremely low or unmeasurable levels within 2 years. In the free-flowing Hanford Reach, the decrease was probably even more rapid, despite the continued presence of the N Reactor and its seepage effluents.

Relative levels of total alpha, beta, and gamma radioactivity of sediment samples collected in the Hanford Reach in August of 1986 are shown in Table 8. While no alpha activity was detected, a slight increase in beta activity was measured moving downriver from Location 1 (above Hanford) to Location 4 (below Hanford). Gamma activity at Locations 2-4 was not significantly different from the level at Location 1. As with other contaminants, it is presumed that the reservoirs behind the major dams, most notably McNary Dam, are important deposition areas for radionuclides which have entered the river at Hanford. Because of the continuous, dynamic reworking of the riverbed throughout the Hanford Reach, and the relatively low influx of new material due to upriver dams, it is not likely that an undetected and dangerous buildup of long-lived radionuclides has occurred in the channel sediments adjacent to the locations sampled.

Table 8.--Total alpha, beta, and gamma radioactivity of sediment collected in the Hanford Reach, Columbia River, August 1986 (see Fig. 1 for station locations).

	Al	cpm) ^{a/}	Beta (cpm) ^{a/}	Gamma (cpm) ^{II}	(Cix10 ⁻⁵)
Location 1 (RM 393)		<20	50	49	4.3
Location 2 (RM 378.5)		<20	50	53	4.6
Location 3 (RM 373)		<20	60	50	4.4
Location 4 (RM 365)		<20	80	52	4.5
Laboratory background		<20	25	49	4.3

^{a/} Ludlum Geiger Counter, Model 14C with Model 44-7 end window GM.

^{b/} Micromedic Systems - 4/200 Automatic Gamma Counter.

CONCLUSIONS

Because of the difficulties of employing conventional sediment sampling techniques in the Hanford Reach, it was only possible to, literally, "scratch the surface." However, because of the dynamic physical processes constantly cutting, reworking, and transporting the riverbed sediments throughout this section of the Columbia River, surface sediments collected from shore may be representative of general sediment quality in this area. On the other hand, the deposition of some of the sediment that would be dredged for a navigation channel through the Hanford Reach certainly occurred during earlier times of unregulated industrial discharge to the river and the full operation of all the reactors at Hanford. Therefore, important questions remain regarding the composition of the deeper channel sediments which would be subject to dredging.

Nevertheless, the surface sediments of the Hanford Reach can be characterized as being extremely coarse (rocks, supported by gravel and sand) and consisting of less than 0.5% carbon; measurable (but not necessarily biologically significant) levels of total heavy metals (most notably Cd, Cu, Pb, Mn, and Zn); undetectable levels of aromatic and chlorinated hydrocarbons; and near-background levels of total alpha, beta, and gamma radioactivity.

From the available data, it cannot be concluded that a strong potential exists for the introduction into the water column, through dredging, of harmful concentrations of contaminants. In the case of heavy metals, further study is required to establish the relative upriver background concentrations (above Wenatchee) and the bioavailability of these metals in the sediments of the Hanford Reach. The levels determined in this study for organic pollutants and radionuclides present no apparent problems.

It is presumed that (1) the sediments collected in this study reflect the general sediment quality of the Hanford Reach and (2) the relatively fine material collected near shore would be more likely to be associated with pollutants than the coarse sediments in the channel. However, only when the surface and subsurface channel sediments themselves are directly examined will these presumptions be affirmed.

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